Ref. 1

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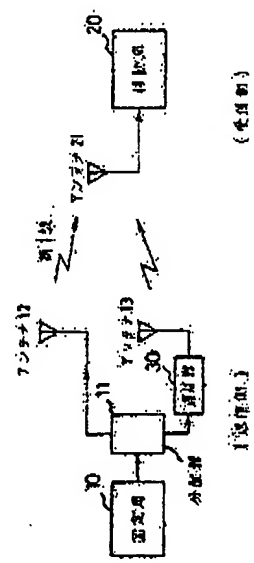
Fixed keyword:
Citation: [, . . ,] (, ,)
Title of invention: Spread spectrum communication equipment

Abstract: [ABSTRACT]

Interaction is not produced, and S/N improves correlation spike output in each transmission wave from a radio antenna after the second of a fixed station in SS communication device comprising a fixed station having plural radio antennas and mobile stations having a single radio antenna by delay gakakatsuteirunode between place appointed hours, a correlation type receiver of the whole receiver of a mobile station so that it is separated from in terms of time.



(Translation)

UM Appln. No. H02-3007 (Laid-open No. H03-94851 - Ref.1)
Filed January 16, 1990;
Laid-open September 27, 1991

Specification

1. Title of Invention

Spread-Spectrum Communication Device

2. Scope of Claim for Utility Model Registration

(1) A spread-spectrum communication device comprising a fixed station connected to at least a first and a second antennas and a mobile station connected to a single antenna, characterized by inserting delay means between said second antenna and the fixed station.

(2) The spread-spectrum communication device according to claim (1), characterized in that delay time provided by said delay means is set at a value equal to two or more chip intervals of PN code.

3. Detailed Description of the Invention

[Technical Field]

This invention relates to an improvement in a spread-spectrum communication device comprising a fixed station and a mobile station.

[Summary of the Invention]

SN ratio is improved in a spread-spectrum communication device which comprises a fixed station connected to a plurality of antennas and a mobile station connected to a single antenna, by delaying signal transmission through the second or subsequent antennas at the fixed station by a predetermined amount of time.

[Prior art]

A system exists carrying out spread-spectrum communication (hereinafter, abbreviated to SS communication) between a communication device of a fixed station, which constitutes a zone, and a communication device of a mobile station by the use of a plurality of antennas, as shown in Figs. 6 and 7.

In the above-mentioned drawings, reference numeral "10" denotes a fixed station; "11", a distributor; and (1, 1) ~ (m, n), antennas for the respective zones, the antennas being connected to the fixed station 10. "20" denotes a mobile station to which a single antenna 21 is connected.

[Problems to be solved by the invention]

The above-mentioned SS communication system has the following problems.

In case where the same data is transmitted at the same time through every antenna (1, 1) ~ (m, n) of the fixed station 10 with SS modulation, a plurality of transmission signals having the same level and having small delay time with respect to each other (equivalent to "multipath") should be received at the mobile station 20 of the recipient that is positioned at an area in which the distance between one of the antennas (1, 1) ~ (m, n) of the fixed station 10 and the antenna 21 of the mobile station 20 is equal to another and which is shown with hatching in Fig. 7. Although SS communication system is generally claimed to be tolerant to multipath fading, it cannot be assured in case of the reception of the transmission wave signals which have the same level and small delay with respect to each other.

To make the problem clear, an event is analyzed where the same data (transmission data) is transmitted from antennas 12, 13 of the fixed station 10 at the same time as shown in Fig. 8. Because the distance between antenna 12 and antenna 21 of mobile station 20 is substantially equal to the distance between antenna 13 and antenna 21, mobile station 20 of the recipient should receive two transmission signals (transmission data) which have the same level and almost the same delay time corresponding to propagation time of radio wave signals. Define here that a transmission signal from antenna 12 is a first wave signal, and that another transmission signal from antenna 13 is a second wave signal. Also, assume here that convolvers are used as correlators provided in the receiver of mobile station 20.

First, when mobile station 20 of the recipient receives the first wave signal, the convolver carries out the correlation operation between the received PN code of the first wave signal and the time reversal thereof, i.e., the reference PN code, so that the

correlation output, which is called "correlation spike", is obtained as shown in Fig. 9. On the baseband transmission, the correlation spike becomes a chopping wave, whose width is equal to one chip interval of the PN code, as shown in Fig. 10.

Next, in case where, subsequent to the first wave signal, the second wave signal whose level is substantially equal to that of the first wave signal is received, the correlation spike of the first wave signal interferes with the correlation spike of the second wave signal if the delay time difference of the second wave signal with respect to the first wave signal is equal to or shorter than two chip intervals of the PN code. For example, if the delay time deference between the first and the second wave signals is equal to or shorter than two chip intervals of the PN code and if the phase difference between the carrier waves included in the correlation spikes of the correlation outputs corresponding to the respective reception wave signals is 180° (i.e., reversed phase), the superposed correlation spike is totally suppressed, as shown in Fig. 11. Therefore, the merit of SS communication system, namely, the S/N improvement effect due to process gain cannot be expected. Hence, data demodulation capability becomes degraded.

Furthermore, in connection with the above, reciprocity is viable between transmission and reception. Therefore, in case where fixed station 10 is on the receive side and mobile station 20 is on the transmit side, the same problem will occur. Also, if the correlator is comprised of a matched filter, the same problem will occur.

Conventional resolution to the above problems is diversity. However, it has a disadvantage of being complex and costly.

[Object of the Invention]

It is therefore an object of the present invention to suppress the influence of the interference of the transmission signals within the receiver in the above-mentioned SS communication device.

[Means by which the problems are solved]

For achievement of the aforementioned object, the gist of an SS communication device according to the present invention is to insert delay means between the fixed station and the second and subsequent antennas of the fixed station.

[Mode of operation]

Transmission wave signals from the second and subsequent antennas are delayed by predetermined amount of time with respect to another transmission signal from the first antenna so that the correlation spikes, which correspond to the respective transmission signals and are produced at the correlators of the receiver of the mobile station, are separated in time domain from one another. Therefore, interference does not occur.

[Embodiment]

Now, this invention will be explained with reference to an embodiment shown in the drawings. Fig. 1 shows an embodiment of an SS communication device according to the present invention, wherein the embodiment is the same or a similar to that of Fig. 6, and "30" denotes a delay inserted between second antenna 13 and fixed station 10. For example, the delay time at the delay 30 is set at a value equal to two or more chip intervals of PN code.

In accordance with the structure, when the same data is transmitted from first and second antennas 12, 13 of fixed station 10, the transmission data from antenna 13 is transmitted with a delay equal to two or more chip intervals of the PN code by means of delay 30 in comparison with the transmission data from antenna 12. The transmission causes no interference even if mobile station 20 is located at the position where the distance between antenna 12 and antenna 21 is substantially equal to the distance between antenna 13 and antenna 21, because the correlation spike of the first wave signal and the correlation spike of the second wave signal upon the use of convolvers as correlators included in the receiver of mobile station 20 are separated in time domain from each other, as shown in Fig. 3. Therefore, its data demodulation capability can be improved.

Next, an event will be analyzed where mobile station 20 is positioned nearer to the antenna 12 than to the antenna 13 and the increase of the propagation delay time of the first wave signal results in small delay time difference between the first and the second wave signals so that the correlation spike of the first wave signal interferes with the correlation spike of the second wave signal. In this event, the level of the first wave signal is smaller than

that of the second wave signal because of the attenuation characteristics of radio waves in accordance with the distance between the transmit and the receive sides. Therefore, the second wave signal becomes predominant, and the influence of the interference does not present significant problem.

The above explanation has been directed to two transmission wave signals from antenna 12 and antenna 13. In case of more signals, the transmission wave signals causing interferences should be subjected to delay process. For example, delay means 31, 32, ... K are inserted between fixed station 10 and second and subsequent antennas 13 ~ K+12, respectively, as shown in Fig. 4, wherein the delay time of the respective delay means are set at values such that the delay time at the delay 30 is equal to four chip intervals of the PN code, ..., the delay time at the delay K is K chips of the PN code, provided that the delay time at the delay 30 is equal to two chip intervals of the PN code.

The transmission under the above settings and upon the use of convolvers as correlators in the recipient results in that correlation spikes are separated from each other in time domain, as shown in Fig. 5, so that interference does not occur at all and that the data demodulation characteristics are improved.

Furthermore, because reciprocity is viable between transmission and reception, the same improvement result can be obtained if fixed station 10 is on receive side and mobile station 20 is on transmit side. Also, if the correlator is comprised of a matched filter, the same result can be obtained.

[Technical Advantages of the Invention]

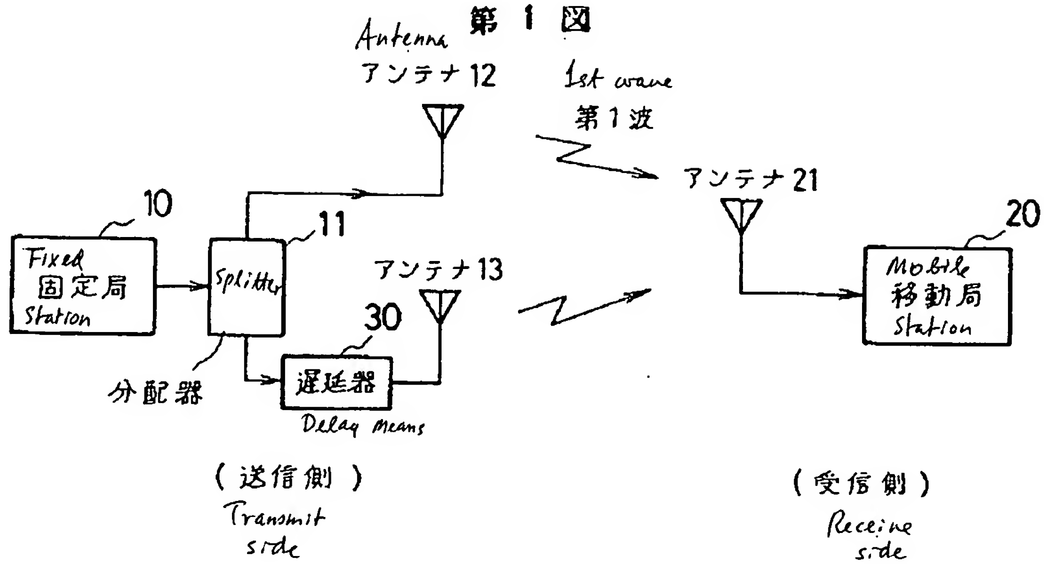
As explained above, the present invention can prevent the occurrence of interference, thereby to improve SN ratio, because, in the SS communication device comprising a fixed station having more than one antenna and a mobile station having only one antenna, the respective transmission wave signals from the second and the subsequent antennas of the fixed station are subjected to the predetermined time delay processes so that the correlation spikes produced at the correlators included in the receiver of the mobile station are separated in time domain from one another.

4. Brief Description of the Drawings

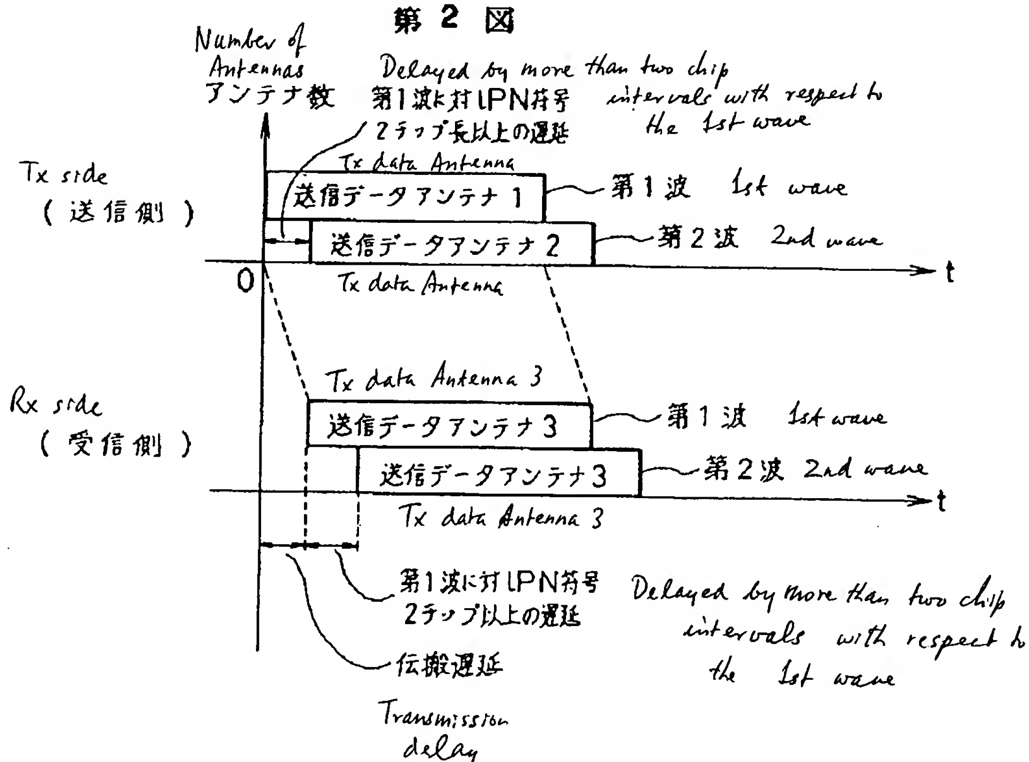
Figs. 1 and 3 are block diagrams showing one embodiment of the present invention; Fig. 2 is a view for use in explanation of its operation; Fig. 4 is a block diagram showing another embodiment of the present invention; Fig. 5 is a view for use in explanation of its operation; Figs. 6 and 7 are views showing one example of a conventional SS communication system; Fig. 8 is a view for use in explanation of its operation; Figs. 9 and 10 are wave-form diagram showing one correlation spike and its wave on base band, respectively; and Fig. 11 is a set of wave-form diagrams which are of the respective correlation spikes in connection with the foregoing conventional system.

10 --- fixed station; 12, 13 --- first, second antennas; 20 --- mobile station; 21 --- single antenna; 30 --- delay.

第 1 図



第 2 図



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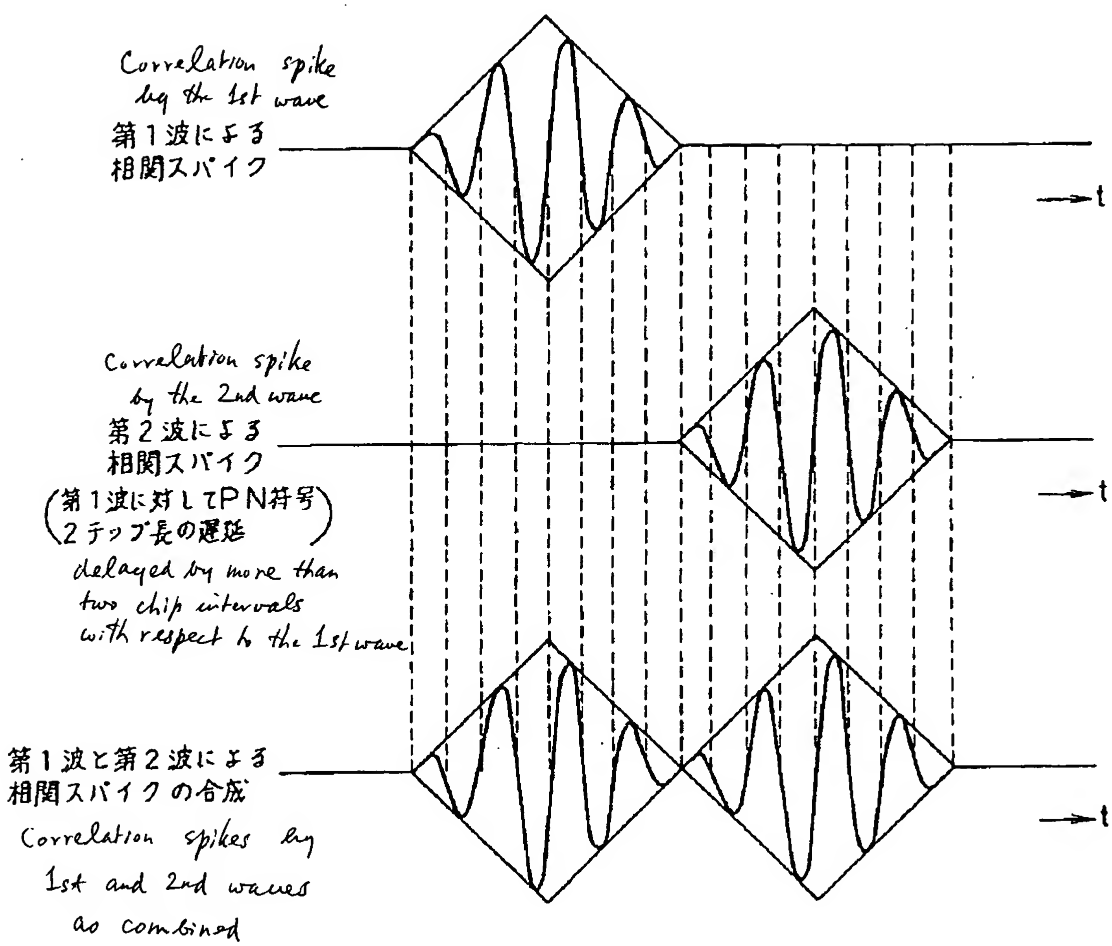
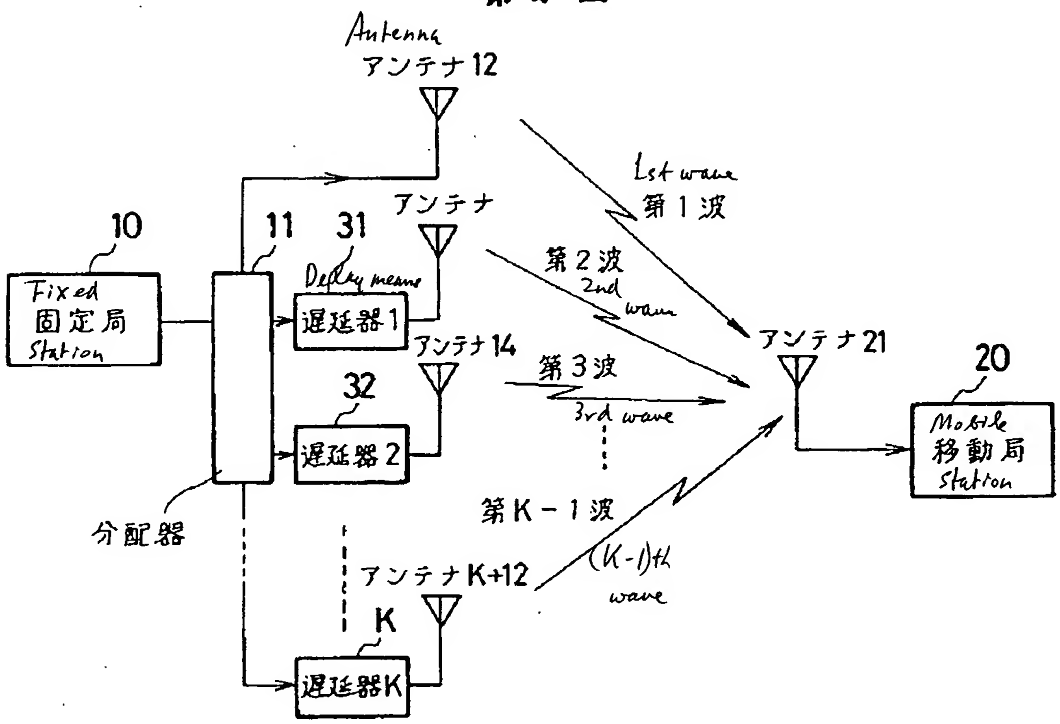
第 3 図

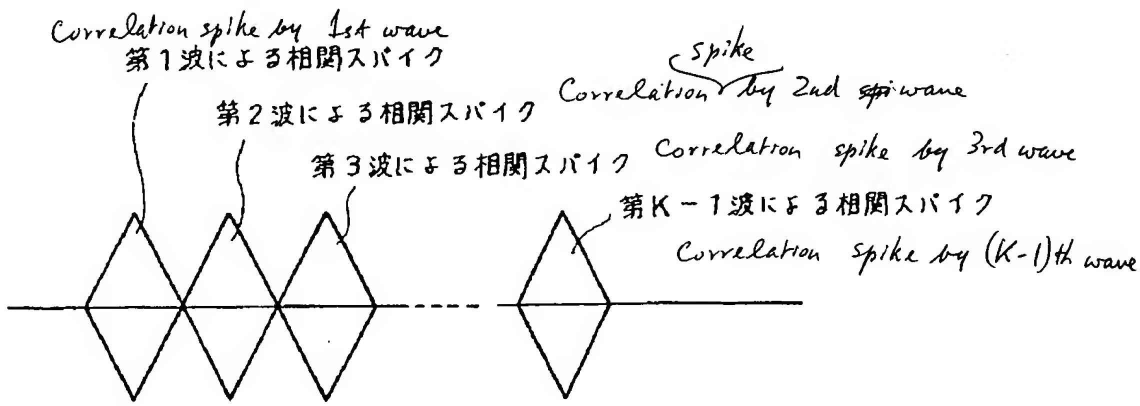


特許出願人 クラリオン株式会社
代理人 弁理士 永田武三郎

第 4 図

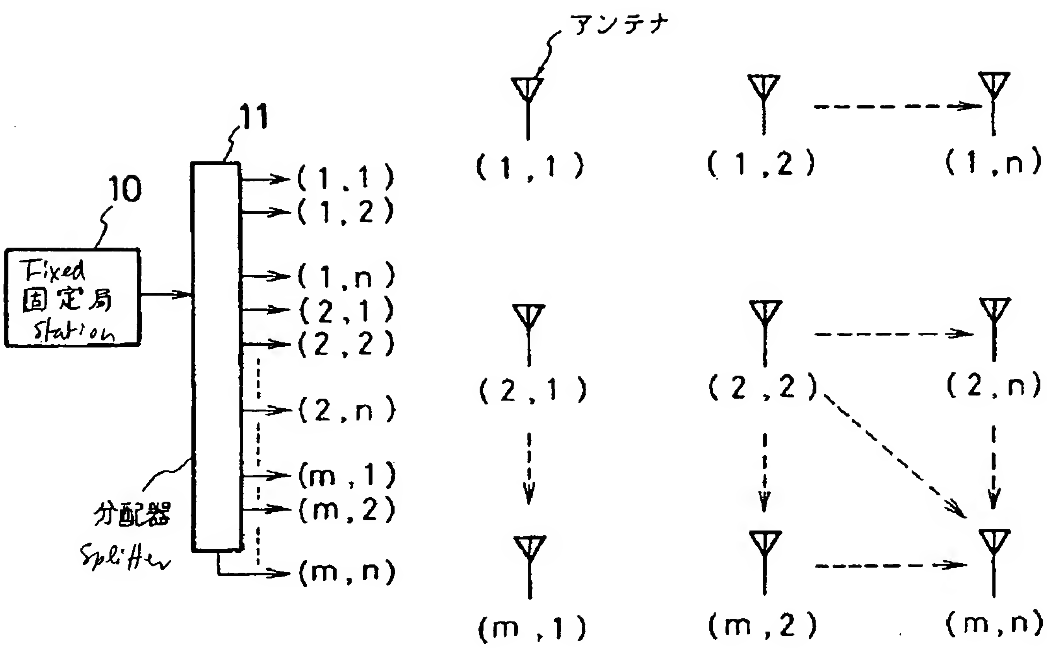

Antenna
アンテナ12
1st wave
第1波
アンテナ
10
11
31
Delay means
Fixed
固定局
Station
遅延器1
第2波
2nd
wave
アンテナ14
第3波
3rd wave
32
遅延器2
アンテナ21
20
Mobile
移動局
Station
第K－1波
分配器
アンテナK+12
(K-1)th
wave
K
遅延器K

第 5 図


Correlation spike by 1st wave
第1波による相関スパイク
第2波による相関スパイク
Correlation spike by 2nd wave
第3波による相関スパイク
Correlation spike by 3rd wave
第K－1波による相関スパイク
Correlation spike by (K-1)th wave

[redacted] [redacted]

第 6 図



実開 3 - 1851
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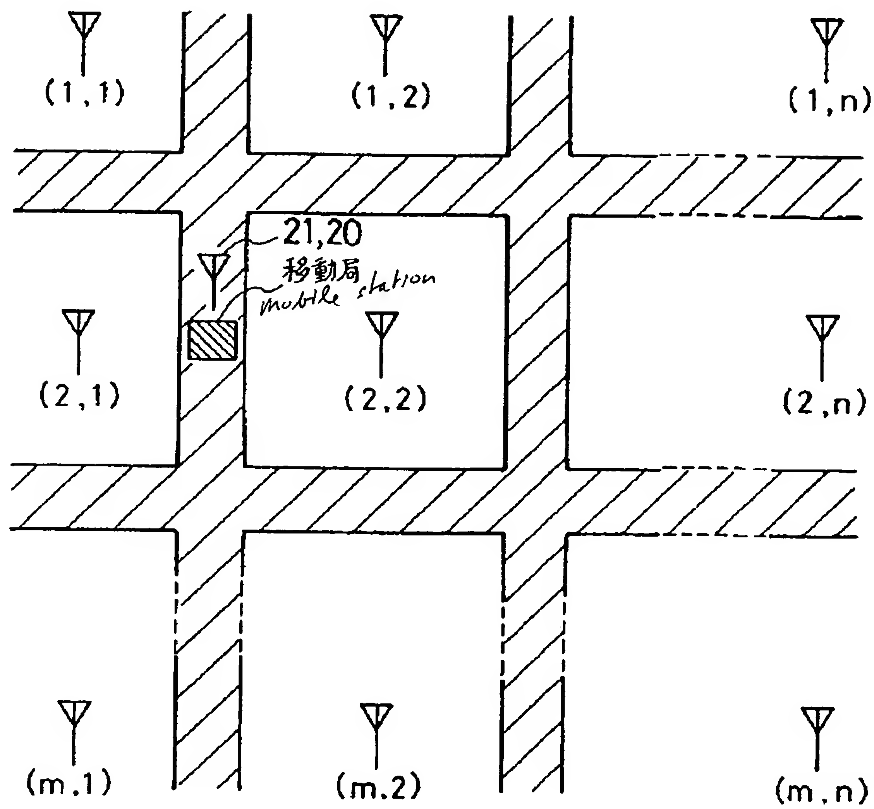
第 7 図



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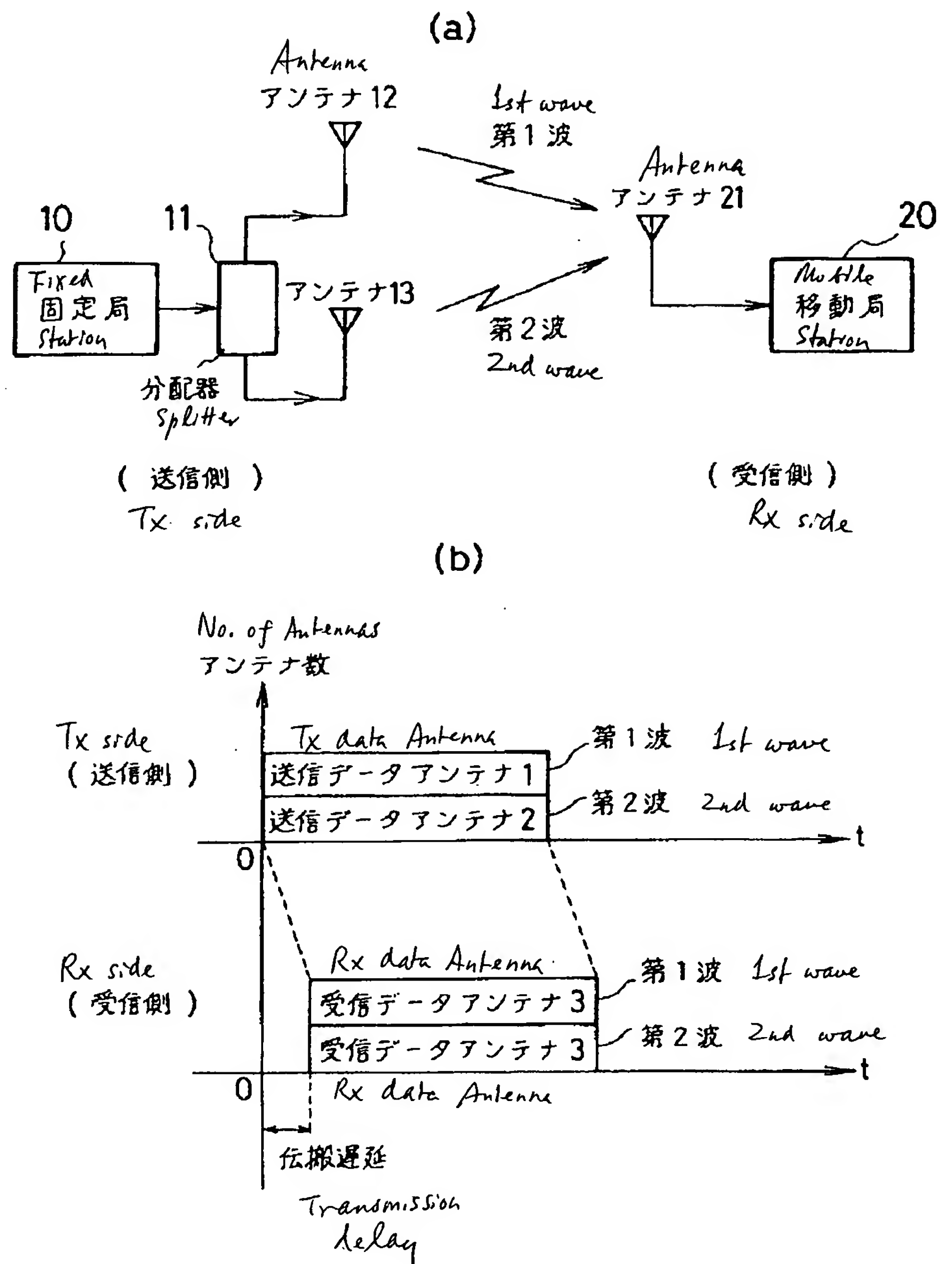
第 8 図



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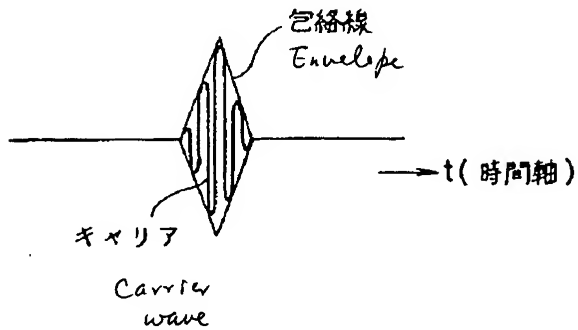
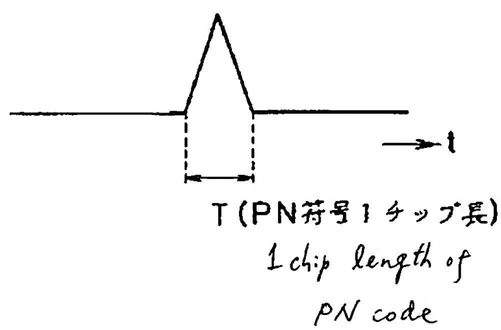
第9図



第10図



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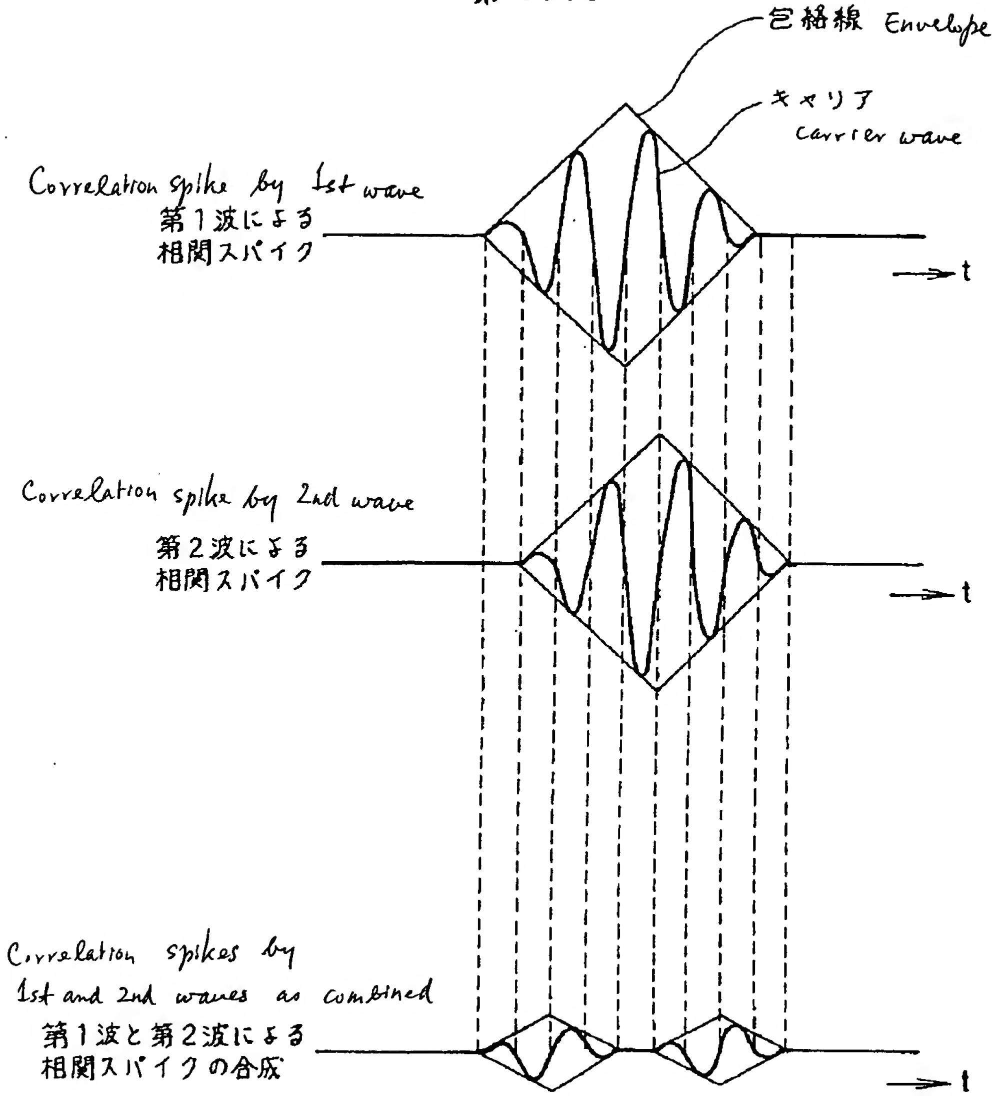
第11図



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